Project Status Report for: March 2001

Project Title: Ultra Low NOx Integrated System for Coal-Fired Power Plants

Project Number: 91890460 **Project Manager:** John Marion

Customer Name: U.S. DOE / Performance Projects **Project Leader:** Charles Maney

GOALS AND OBJECTIVES:

Develop low cost, retrofit NO_x control technologies to address current and anticipated, near term emissions control legislation for existing coal fired utility boilers. Specific goals include:

- Achieve < 0.15 lb/MMBtu NO_x for eastern bituminous coals
- Achieve < 0.10 lb/MMBtu NO_x for western sub-bituminous or lignitic coals
- Achieve economics at least 25% less than SCR-only technology
- Validate NOx control technology through large (15 MWt) pilot scale demonstration
- Evaluate the engineering feasibility and economics for representative plant cases
- Provide input to develop commercial guidelines for specified equipment
- Provide input to develop a commercialization plan for the resultant technologies

WORK PLANNED FROM PREVIOUS REPORT:

Task 2.4 – Advanced Control System Design

- Complete calibration / testing of coal mass flow meters.

Task 3.1 – Test Planning & Facility Preparation

- Receive sub-bituminous coal and begin pulverization.
- Finalize week 2 test matrix for BSF.
- Make needed modifications / preparations for BSF week 2 testing.

ACCOMPLISHMENTS FOR REPORTING PERIOD:

Task 2.4 – Advanced Control System Design

- *Complete calibration / testing of coal mass flow meters.*

A set of 12, ABB Kent-Taylor mass flow meters was used in last fall's BSF testing to measure, and allow for control over, the coal flow rate to each of the facilities 12 coal nozzles (3 elevations x 4 corners). Results from this work suggested little to no change in combustion performance for the subject medium volatile bituminous coal as transport air and coal flow distribution was varied from a condition of relative imbalance to a condition of relative balance as indicated by individual meter coal flow rates. In order to validate the experimental results, and verify the performance of the meters, a calibration experiment was

initiated in March using a barrel with a bag filter connected to each of the 12 BSF coal lines to allow the individual coal flow rates to be determined by the barrel weight.

During this work a series of 5 barrel tests were performed to verify the operation of the coal mass flow meters and resultant combustion test conditions. For this work coal was fed for approximately 15-20 minutes for each test at rates ranging from 3,000 to 5,000 lb/hr (re. up to and beyond the nominal week 1 combustion test feed rate of 4,400 lb/hr). Upon completion of each test, the barrels were weighed and the output from the mass flow meters (mass flow rate) was integrated to allow comparison between the actual and the meter indicated amount of coal. Unfortunately, this testing showed poor agreement (as large as 40% difference) between some of the coal mass flow meter measurements and the barrel weights. Subsequent to this finding the vendor (ABB Kent-Taylor) was notified of this problem. They then executed their own test campaign with some flow meters that were produced in the same batch as those installed on the BSF and proposed a solution that involved both hardware and software changes.

In April the ABB Kent Taylor personnel will come to Windsor in order to examine the installed system and implement potential solutions. BSF testing, originally scheduled to be completed by April 14, 2001 has thus been pushed back to the week of April 22, 2001 to accommodate this work.

Task 3.1 – Test Planning & Facility Preparation

- *Receive sub-bituminous coal and begin pulverization.*

A sub-bituminous coal from the Powder River Basin has been received for use during the second test period in the BSF. The Kennecott Energy Company donated 300 tons of their Cordero Rojo Complex coal, including transportation to the Windsor site, in support of the test campaign. Due to its high volatile content (Table 1) and high char reactivity, the Cordero Rojo coal is very amenable to staged combustion process NOx reduction techniques as these factors allow the majority of the coal's fuel bound nitrogen to be released in the sub-stoichiometric region of the boiler where it can effectively be reduced to N_2 rather than combining with oxygen to form NO. As a result, it is expected that the NOx emissions from the Cordero Rojo coal will be the lowest recorded during project work.

The interest of Kennecott Energy in this project and their willingness to support it through the contribution of the Cordero Rojo coal are greatly appreciated. The contribution of the Burlington Northern railroad in donating part of the transportation costs is also acknowledged.

In addition to the Cordero Rojo coal, a high volatile Eastern bituminous coal was selected for fire in the BSF during the 2nd test period to meet the program objectives of demonstrating system performance across a range coal types. Seventy two (72) tons of the high volatile Eastern bituminous coal has been purchased and received in support of the second BSF combustion test period.

Pulverization of the noted fuels, originally planned to begin in March, has been delayed to mid-April to allow for time for resolution of the above mentioned coal mass flow meter problems.

Table 1. BSF Test Coal Analyses

	Test Week 1	Test Week 2	Test Week 2
			Cordero Rojo
	Med Vol Bit	High Vol Bit	Sub Bit
Proximate			
VM	22.5%	34.5%	30.7%
FC	63.1%	52.0%	33.8%
FC/VM	2.8	1.5	1.1
VM, DAF	26.3%	39.9%	47.4%
Ultimate			
Moisture	0.9%	4.0%	29.6%
Hydrogen	4.0%	4.7%	3.4%
Carbon	74.7%	70.4%	48.8%
Sulfur	1.4%	2.4%	0.3%
Nitrogen	1.3%	1.4%	0.7%
Oxygen	4.2%	7.6%	11.5%
Ash	13.6%	9.5%	5.7%
Total	100.0%	100.0%	100.0%
HHV, BTU/lb	13,109	12,624	8,429
O/N	3.2	5.4	15.8
lb N/MMBTU	0.99	1.11	0.87
lb S/MMBTU	1.04	1.90	0.37
lb Ash/MMBTU	10.3	7.5	6.8

- *Finalize week 2 test matrix for BSF.*

The main variables that will be examined in the second period of combustion testing in the BSF are listed in Table 2. The noted variables represent an extension of the test work performed in October, along with the addition of some new parameters (including coal type) to attempt to achieve additional NOx reduction.

Among the new ideas previously noted (refer to the February 2001 month-end report), oxygen enrichment was formerly under consideration as a means to enhance ignition and lower NOx emissions under globally reducing conditions as part of the upcoming test campaign. However, the final design of the oxygen delivery system for test use resulted in higher than desired costs due to required material cleaning procedures for oxygen use. Given that this work would have been an out-of-scope and therefor out-of-budget effort, it was decided to not include O_2 enrichment during the upcoming BSF testing.

Table 2. Variables List for Week 2 BSF testing.

1. **MBZ Stoichiometry**
2. **Staged Residence Time**
3. **Near Field Stoichiometry**
   - a **Transport air to fuel ratio**
   - b **Fuel air flow**
   - c **Subcompartmentalization**
4. **Transport Air & Fuel Flow Balance**
   - a **Coal flow balancing**
   - b **Vertical coal bias (*top coal %*)**
5. **SOFA Elevation (*1 vs. 2*)**
6. **SOFA Mixing**
   - a **SOFA Velocity (*field equivalent*)**
   - b **SOFA Yaw**
7. **Boiler Load**
8. **Coal Fineness (*sub-bit coal*)**
9. **Excess Air (*USOFA flow variation*)**
10. **Bottom End Air**
    - a **Quantity**
    - b **Location / separation distance**
    - c **Direction (yaw / tilt)**
11. **Coal Ballistics**
    - a **Low-set / compressed WB**
    - b **Coal yaw**

- *Make needed modifications / preparations for BSF week 2 testing.*

Work is well underway to prepare the BSF for the week 2 test work. Furnace deslagging, necessary to reset the BSF thermal environment and clear the near burner field from potential obstruction (see February 2001 month end report) revealed damage to the lower SOFA assemblies and the North ignitor horn. During this work, leaks in the BSF water jacket were also discovered in 3 of the 2" sample ports and near the main windboxes. In March, needed repairs were made to the BSF water jacket as well as the SOFA assemblies and the ignitors. Additional repairs to and maintenance of the coal transport and storage systems have also been completed. Leaks recently discovered in the large external flue gas heat exchanger are also currently being repaired.

Required recalibration of facility pressure cells is also well underway, along with checkout of all thermocouples, dampers, and required electronic equipment. A main windbox combustion air damper actuator which failed near the end of the last test has not been repaired yet as the new actuator that was received was faulty. However, it is expected that a second, new damper actuator should be available and installed to meet the current late April test schedule

Task 8 – Project Management

A technical paper entitled "Ultra-Low NOx Integrated System for Coal Fired Power Plants was submitted to the International Joint Power Generation Conference (IJPGC) to be held in New Orleans, LA on June 4-7, 2001. The paper describes ALSTOM Power Inc.'s field experience implementing low-NOx retrofits of T-fired utility boilers and the on-going development efforts under this project to further reduce NOx emissions for tangential coal-fired utility boiler application.

WORK PLANNED FOR NEXT REPORTING PERIOD:

Task 2.4 – Advanced Control System Design

- Resolve accuracy of coal mass flow meters and determine methodology for testing of coal flow balancing in the BSF.

Task 3.1 – Test Planning & Facility Preparation

- Complete preparations for week 2 BSF testing.

Task 3.3 – Combustion Testing and Cleanup

- Complete the second combustion test period in the BSF.